The Computer Aided Management of an Off-Line Magnetic Tape Storage Facility Utilizing a Data Base Management System

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by

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ABSTRACT

This paper examines the management problems which arise when a computer center provides magnetic tape storage services for its user population. A computer aided management scheme utilizing a Data Base Management System is presented as a solution to these problems. The sample scheme presented here uses the MRI System 2000 package but any similar system would probably work as well.

INTRODUCTION

Any computer center with magnetic tape capability deals in some way with three types of magnetic tapes: Archive Tapes, tapes which are no longer actively used but must be retained; Transient Tapes, tapes available to the computer system yet very mobile (i.e., frequently physically transported from one site to another); and Off-Line Tapes, tapes frequently made available to the computer system but not mobile. Each type of tape has its own special storage requirements.

There are two factors which determine the complexity of the management system used for each type of tape storage. They are volume and turnover rate. Since transient tapes by nature are mobile, the computer center does not need to retain any information from these tapes once they leave the computer center (unless, of course, the computer center owns the tapes). Therefore there is no management involved for transient tapes except perhaps to provide temporary rack space for them while they are in the building. Clearly, the management problem is potentially most complex for off-line tape storage since both volume and turnover rate are involved. (Obviously, for a small number of tapes with a low turnover rate there is no real management problem.) A simple notebook would be sufficient to record all the necessary data. However, as the number of tapes and the turnover rate increase the problem soon grows out of hand. In fact the problems in maintaining up-to-date records, record assessibility, and accurate billing procedures are soon beyond human capabilities.

The following proposed computer aided management scheme is directed toward eliminating the problems of off-line tape storage. However, it could be modified slightly and applied to archive tapes, if the volume were large enough, and to transient tapes in some special circumstances.

DESIGNING A STORAGE SCHEME

The first step when designing an off-line tape storage scheme is to decide how the tapes are to be stored. For the proposed scheme, each tape in storage is assigned a unique integer storage number (SN) between 1 and N. This number corresponds to a slot in the storage racks where the tape is kept (where N is the number of slots available).

The next step is to decide what data, in addition to the SN, needs to be recorded in the data base. The proposed scheme uses the following items:

1) User Number (UN) - Used for billing purposes.
2) Tape Name (TN) - Used for added identification and security.
3) Last Name (LN) - Last name of the person responsible for the tape.
4) First Name (FN) - First name of the person responsible for the tape.
5) Department (DP) - The University department or company with whom the responsible person is associated.
6) Phone Number (PN)- Phone number of the responsible person.
7) Date (DT) - The date the tape was entered into storage (used for determining storage charges).

Of these items the UN, SN, TN and DT are kept on the gummed label. In order for the tape to be accessed the accessor must obviously know the

correct SN and TN. In addition, only the person responsible for the tape may authorize changes to the TN, transfer of the tape to a new slot (i.e., change the SN), or removal from the storage facility. Since the tapes are not physically accessible to the users the actual changes are made by the tape librarian.

The third step is to decide which of the above items are key items. Depending on the data base management package being used this could be a very important step because it could determine which items can be sorted, which items can be used for retrieval, and most important the amount of time necessary to operate on the data base. The proposed scheme designates UN, SN, LN, FN, DP and DT as key items.

The fourth step is to establish some conventions to follow when dealing with the data base. The proposed scheme uses the following:

1) When a tape is removed from storage the following changes are made to the data base: The SN is unchanged, UN is set to '0', the LN is set to 'PERMANENTLY', the FN is set to 'REMOVED', the DT is set to the date of removal, and the rest of the items are set to '.'.
2) When the storage charges for a tape go unpaid the UN is set to '1' and the rest of the items are left intact.
3) When a tape is removed from storage the slot (SN) it occupied is not reassigned to another tape until one full billing period has elapsed since the time of removal. (A billing period is three months.)

The fifth and final step is to write a document explaining how to use the data base. This step is very important since the people using the

data base will most likely be clerks and therefore not computer oriented. The proposed scheme goes one step further and, using the S2K string capabilities, defines several easily applied commands which will cover nearly all everyday transactions. (See Appendix A.)

REVIEW OF THE PROPOSED SCHEME

The proposed scheme consists of:

1) A unique integer (SN) for every tape in storage.
2) A UN, TN, LN, FN, DP, DN, and DT for every SN.
3) The UN, SN, LN, FN, DP and DT designated as key items.
4) Three basic utilization conventions.
5) Several easy to use commands.

UTILIZING THE PROPOSED SCHEME

The proposed scheme would be most useful if implemented on a timesharing system. That way, in addition to providing the capability for error free billing, it would eliminate the problems associated with keeping records up to date and accessible.

Clearly, commands I-X (REMOVE, ADD, ALTER, COUNT, COUNTALL, COUNTMT, COUNTU, COUNTA, COUNTD, INQUIRE) in Appendix A are most useful in an interactive environment. They should be sufficient for deleting tapes, adding tapes, and updating information about current tapes. In addition, commands IV-X can, within seconds, provide answers to any questions about off-line tapes that might arise during the average day. Specifically, they can directly provide the following statistics: The number of tapes belonging to any given UN, DP, LN, or FN (COUNT); the total number of slots defined (COUNTALL); the number of empty slots (COUNTMT); the

number of occupied slots (i.e., number of tape in storage) (COUNTU); and the number of tapes added (COUNTA) or deleted (COUNTD) during a specified period.

In addition, these commands can indirectly provide the following percentages: percent of total tapes in storage that are owned by any given UN, DP, FN, or LN, percent of available slots that are used, and percent of available empty slots. Further, command X (INQUIRE) can provide all the information stored in the data base relating to any given SN, UN, DP, LN or FN. These eight commands thus solve the problems of keeping the records up-to-date and accessible.

While commands XI-XV (SUMMARY,REPORTSN,REPORTUN,REPORTDP,REPORTLN) are most useful for infrequent periodic report generation, commands VIII-X could prove useful for both timesharing and report generation. These commands would come in to play if the proposed scheme were not available on a timesharing system. Periodically, usually every billing cycle, they would be used to generate a new set of reports for the next billing period. The four reports would each be sorted on different keys. This would permit access to the storage records given any one of four bits of information, UN, SN, DP, or LN. While using the scheme on a non-timesharing system eases the problem of access it does not solve the problem of keeping the records up to date. As the billing period increases in length, the problem of updating the records also increases, especially if the turnover rate is high.

The billing accuracy problem can be solved two ways:

1) By having the data base management package produce a machine readable report which is processed by a billing program.

2) By making the data base directly available to the billing program.

The second alternative is the one used in the above scheme. All information in the off-line-tape data base is available to FORTRAN or COBOL programs via the System 2000 procedural language interface. Thus, the billing program, while adding up other charges (CPU, paper, disk storage, etc.), can add in tape storage charges with a minimum of error and human intervention. In addition, depending on the installation's billing policies the billing program could update certain fields in the data base such as the last billing date and storage charges to date. While these fields are not in the proposed scheme they could easily be added.

DATA BASE SECURITY

Obviously the data base, with its sensitive information (e.g., user numbers and tape names), must be protected from unauthorized access. The needed security will normally come from two sources: 1) restricted access to the computer provided by the operating system and 2) restricted access to the data base itself provided by the data base manager. For example, access to a data base through S2K running under KRONOS 2.1 on a CDC 6000 series machine first requires a valid user number and password to access the computer and then a valid S2K password to access the data base. These restrictions should be sufficient for most computer centers. However, depending on the individual installation more or less security may be appropriate.

DATA BASE BACK-UP

Until such a time that computer systems (hardware & software) become 100 percent reliable, it will be necessary to maintain a back-up of the data base. For an "average" size data base it is suggested that N levels of back-up be maintained, with two copies of the data base retained at each level. The value of N, as well as the frequency with which back-up copies are taken, will of course depend on the needs of the individual installation. Two levels (N=2) of back-up should be sufficient for most installations while the frequency at which back-up copies are made will be determined by volume, turn over rate, and equipment reliability.

POSSIBLE "FAST RACK" IMPLEMENTATION

If off-line tape storage racks are a fair distance from the tape transports of a computer facility it may be advantageous to implement a "Fast Access Rack for Often Used Tapes," (FAROUT). This rack would be considerably closer to the tape transports and contain the most frequently used tapes. If this procedure is used, an additional field should be added to the data base containing the number of the slot that a tape occupies in the FAROUT. Each billing cycle (or oftener if required), the billing program could decide, based on access statistics, if a tape should be moved to or removed from the FAROUT. It could produce a list of which tapes are to be moved as well as automatically updating the SN and FN (Fast Rack Number). In fact it might be feasible in some systems to keep the access count for a tape in the data base as an additional field. Both of these possibilities have many factors, pro and con, which would have to be weighed by each individual installation.

CONCLUSIONS

It has been shown that the problems of up-to-date records, record accessibility and accurate billing can most effectively be solved by using an interactive data base management package. However, even a "batch mode" management package is superior to any form of non-computerized accounting for a large storage facility with a high turnover rate. In the end it will be the needs and resources of each individual installation that will dictate what method (batch or interactive) is used, what data is kept, what billing procedure is used, and what back-up and security measures are used. The scheme proposed here at least represents a good starting place.

APPENDIX A

Notation: [A / B / C] = A or B or C; and N and M = any character string.

I. *REMOVE([UN / SN / DP / LN / FN],N,DATE)

Remove all tapes with [UN / SN / DP / LN / FN] = N. Set LN = "PERMANENTLY",

FN = "REMOVED", UN = "0", DT = DATE, and TN = DP = PN = '.'

II. *ADD(UN,SN,TN,LN,FN,DP,PN,DT)

Add a tape to slot SN with the specified UN, TN, LN, FN, DP, PN, and DT.

III. *ALTER([UN / TN / LN / FN / DP / PN / DT],N,[UN / SN / DP / LN / FN],M)

set [UN / TN / LN / FN / DP / PN / DT] = M, for every tape where [UN / SN / DP / LN / FN] = N.

IV. *COUNT([UN / DP / LN / FN / DT],N)

Print a count of all SN's such that [UN / DP / LN / FN / DT] = N

V. *COUNTALL*

Print a count of all SN's that are defined.

VI. *COUNTMT*

Print a count of all SN's that are defined but have no tape associated with them.

VII. *COUNTU*

Print a count of all SN's that are defined and have a tape associated with them.

NOTE: *COUNTALL* = *COUNTMT* + *COUNTU*

VIII. *COUNTA(N,M)

Print a count of the tapes that were added to the library such that $N \leq DT \leq M$.

IX. *COUNTD(N,M)

Print a count of the tapes that were deleted from the library such that $N \leq DT \leq M$

X. *INQUIRE([UN / SN / DP / LN / FN], N)

List UN, SN, TN, LN, FN, DP, PN, DT ordered by SN for every SN.

such that [UD / SN / DP / LN / FN] = N.

XI. *SUMMARY([UN / DP / LN / FN / DT])

List every unique value of [UN / DP / LN / FN / DT] and a count of how many SN's are associated with each

XII. *REPORTSN(A,B)

List UN, SN, TN, LN, FN, DP, PN, DT ordered by SN for every SN such that $A \leq SN \leq B$.

XIII. *REPORTUN*

List UN, SN, TN, LN, FN, DP, PN, DT, ordered by UN subordered by SN for every SN.

XIV. *REPORTUN*

List UN, SN, TN, FN, LN, DP, PN, DT, ordered by DP subordered by LN, FN, and SN for every SN.

XV. *REPORTLN*

List UN, SN, TN, FN, LN, DP, PN, DT ordered by LN subordered by FN and SN for every SN.